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Machijima et al.

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(54) **POSITION DETECTING DEVICE FOR FLUID PRESSURE CYLINDER**

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(58) **Field of Classification Search**
CPC F15B 15/2807; F15B 15/2892; H05R 7/04
See application file for complete search history.

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(57) **ABSTRACT**

A sensor holding member holding a position sensor and an attachment member that attaches the sensor holding member to a cylinder tube are formed separately. The sensor holding member is placed with a sensor attachment groove oriented in the direction of the axis of the cylinder tube and in contact with the outer surface of the cylinder tube. The attachment member is placed so as to straddle the sensor holding member. By tightening an attachment screw and fixing the attachment member with an attachment band, the sensor holding member is pressed against and fixed to the outer surface of the cylinder tube by the attachment member. Loosening the attachment screw allows the sensor holding member to be displaced relative to the attachment member in the direction of the axis of the cylinder tube.

16 Claims, 6 Drawing Sheets

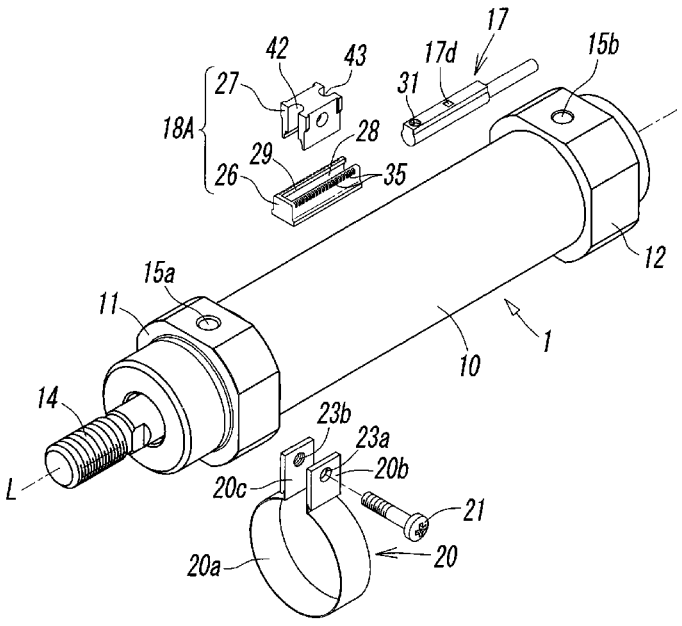

FIG.1

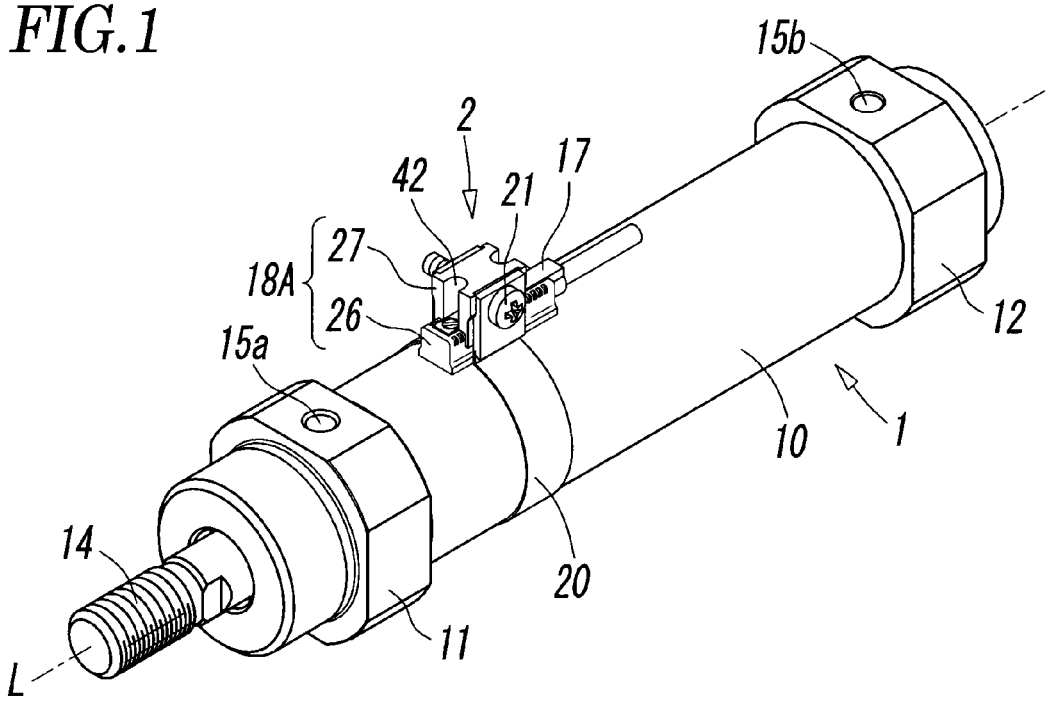
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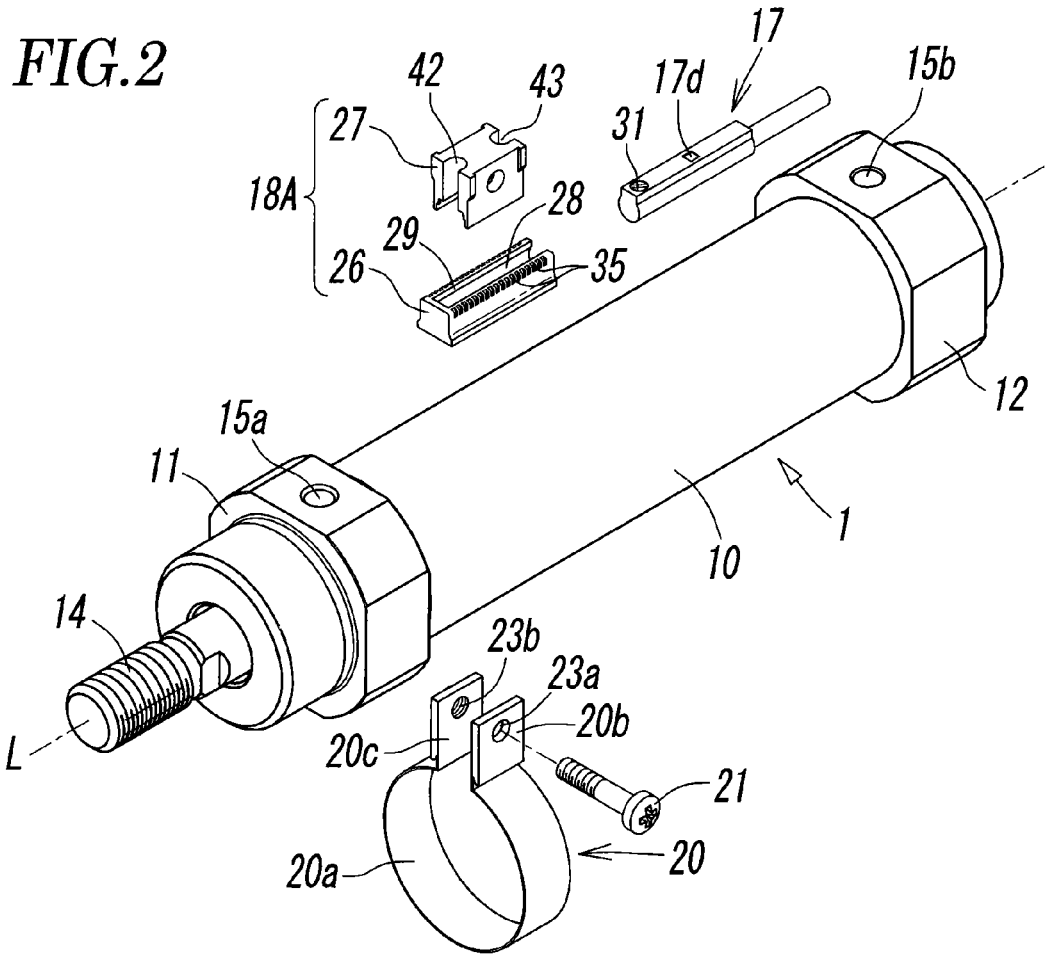
FIG.2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42
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27
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18A
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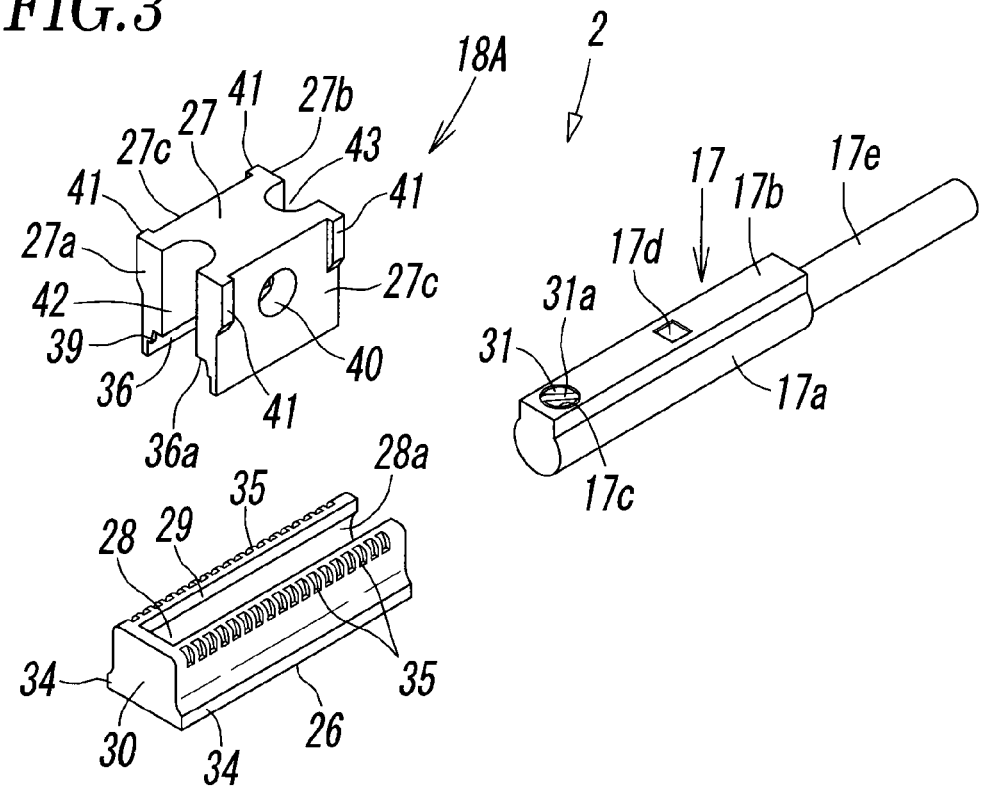
11
10
1
14
23b
23a
20b
20c
21
20
20a
L

FIG.3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2
41
27b
27
43
27c
41
41
27a
27c
42
39
40
36
41
36a
28a
35
28
29
35
34
35
30
26
34
17
17b
17e
17d
31a
31
17a
17c

FIG.4

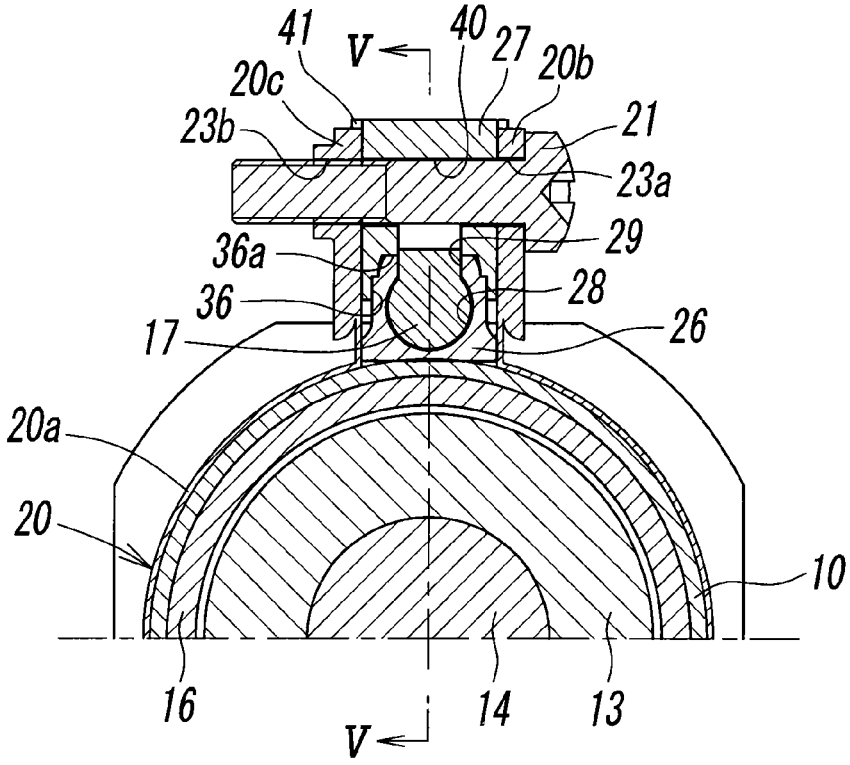

41
V
40
27
20b
20c
21
23b
23a
29
36a
28
36
26
17
20a
20
10
16
14
13
V

FIG.5

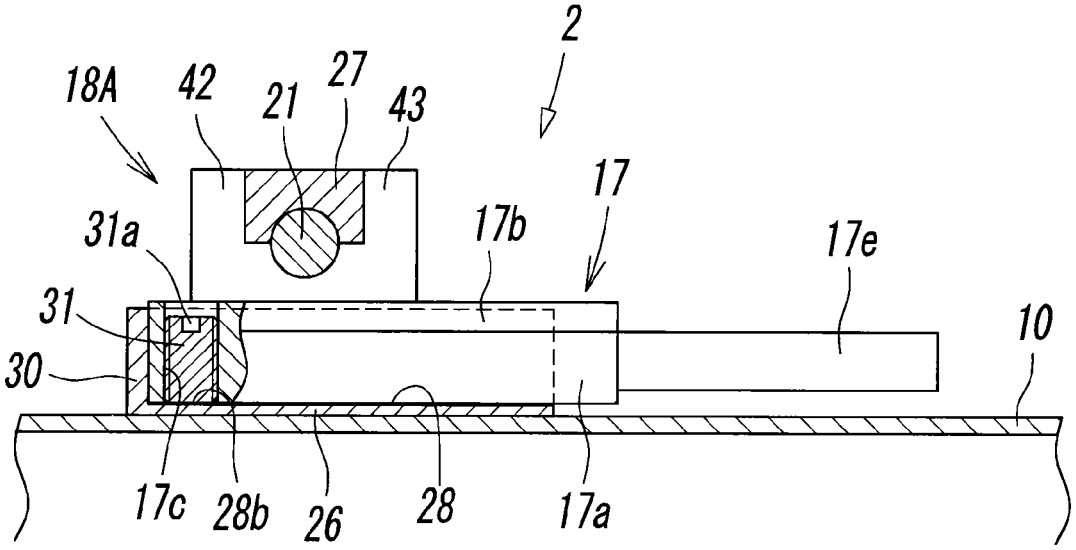

2
18A
42
21
27
43
17
31a
17b
17e
31
10
30
17c
28b
26
28
17a

FIG.6

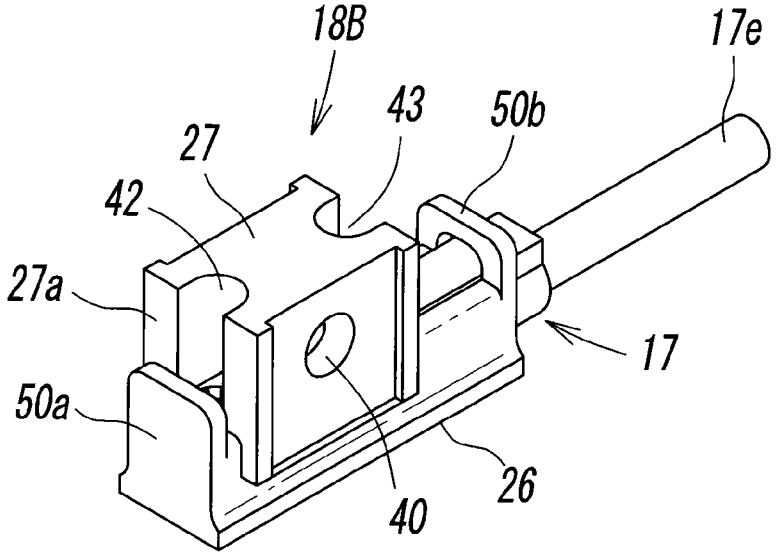

18B
17e
43
50b
27
42
27a
17
50a
26
40

FIG. 7

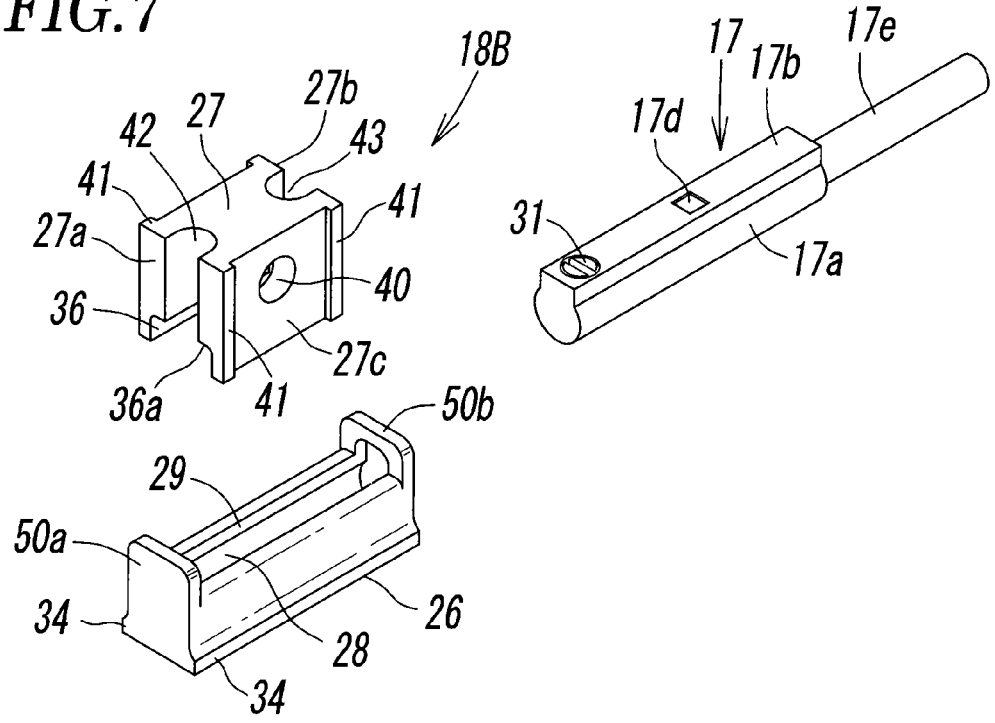


FIG. 8

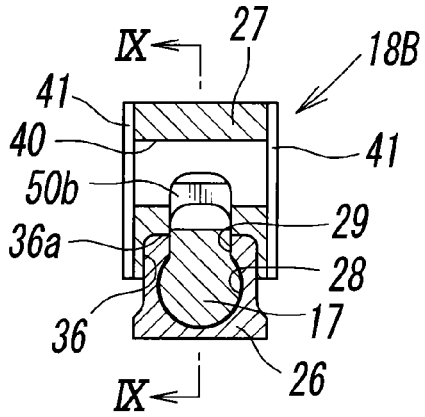


FIG. 9

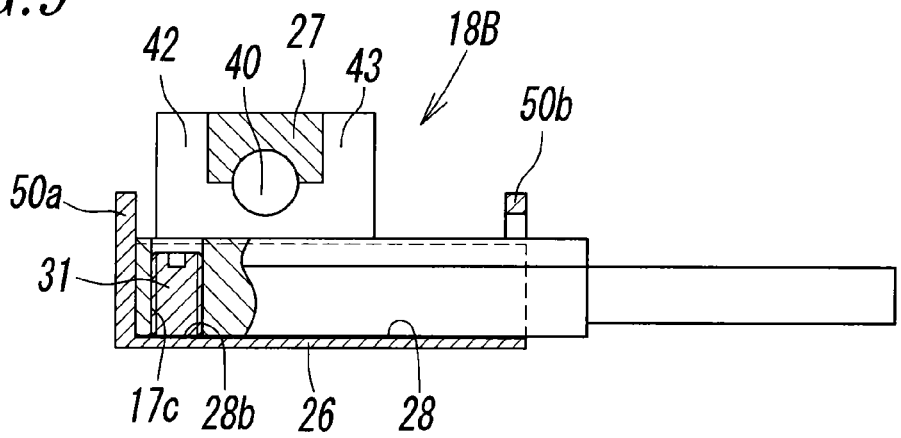
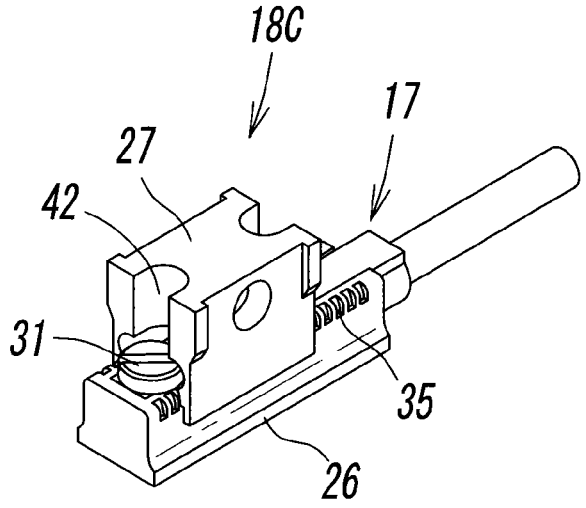


FIG.10


18C
17
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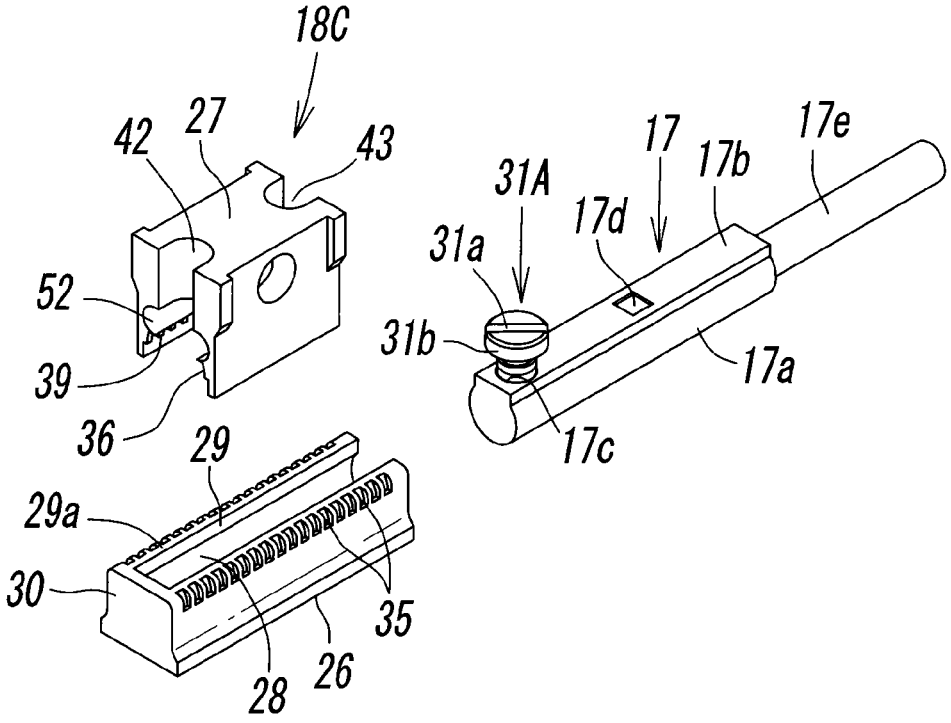
42
31
35
26

FIG.11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31b
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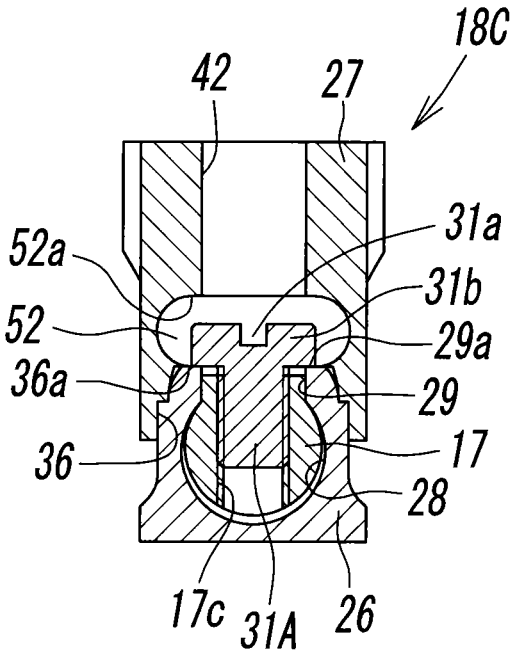
17d
17b
17e
17a
17c

FIG.12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31a
52a
31b
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36a
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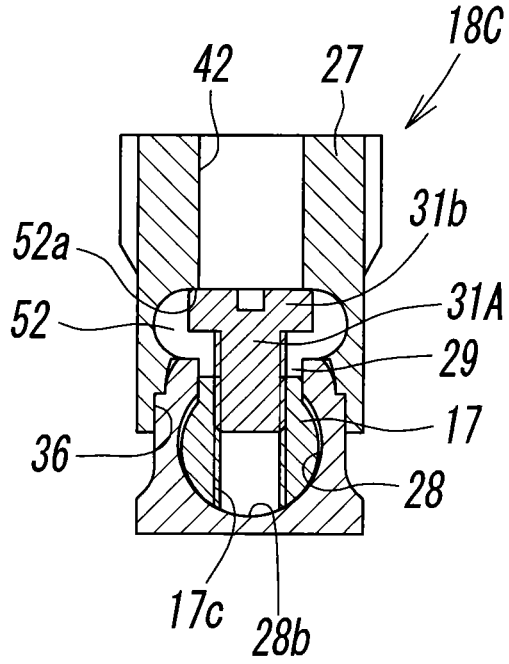
17
36
28
17c
31A
26

FIG.13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52a
31A
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17c
28b

POSITION DETECTING DEVICE FOR FLUID PRESSURE CYLINDER

TECHNICAL FIELD

The present invention relates to a position detecting device that detects the operating position of a piston of a fluid pressure cylinder, and more specifically, it relates to such a type of position detecting device that a position sensor is attached to a cylinder tube using an attachment band.

BACKGROUND ART

In general, a position detecting device is attached to a fluid pressure cylinder in order to detect the operating position of a piston and to use the detection signal as a signal for controlling the fluid pressure cylinder. This position detecting device detects the magnetism of a permanent magnet attached to the piston with a magnetically sensitive position sensor attached to the outer surface of the cylinder tube. In order to attach the position sensor to the outer surface of the cylinder tube, various mechanisms have been used.

For example, in Patent Document 1, there is disclosed such a position detecting device that a sensor holder having a sensor insertion groove having a narrow opening is attached to the outer surface of a cylinder tube with an attachment band (belt-like band), a position sensor is placed into the sensor insertion groove, and the position sensor is fixed to the sensor holder with a locking screw screwed into the position sensor. In this position detecting device, the position adjustment of the position sensor is performed by loosening the locking screw, moving the position sensor to the optimum detecting position in the sensor holder, and tightening the locking screw again at that position.

However, a method in which only a position sensor is moved to adjust the position as in this position detecting device lacks the flexibility in position adjustment. For example, when the attachment position of the attachment band relative to the cylinder tube is restricted, it is not enough to move the position sensor.

Position adjustment can also be performed by moving the sensor holder. However, in this case, it is necessary to connect the sensor holder and the attachment band with an attachment screw and an elongate hole, and the sensor holder is easily displaced in the direction of the elongate hole by vibration or the like.

CITATION LIST

Patent Literature

Patent Document 1: Japanese Unexamined Patent Application Publication No. 2004-125150

SUMMARY OF INVENTION

Technical Problem

It is an object of the present invention to provide a position detecting device for a fluid pressure cylinder in which a position sensor can be position-adjustably attached to a cylinder tube with an attachment band and a sensor holder, the degree of freedom in position adjustment is high, and the position sensor is not displaced by vibration.

Solution to Problem

To attain the above object, a position detecting device of the present invention includes a position sensor that detects the position of a piston of a fluid pressure cylinder, a sensor holder that position-adjustably holds the position sensor, and an attachment band that attaches the sensor holder to the outer periphery of a cylinder tube.

The attachment band has a band main body surrounding the outer periphery of the cylinder tube, and a pair of clamping portions formed at both ends of the band main body so as to face each other, the sensor holder is clamped between the pair of clamping portions, and the sensor holder is fixed between the clamping portions by moving the pair of clamping portions toward each other with an attachment screw.

The sensor holder includes a sensor holding member having a sensor attachment groove in which the position sensor fits, and an attachment member clamped between the pair of clamping portions of the attachment band, and the sensor holding member and the attachment member are formed separately. The sensor holding member is placed, with the sensor attachment groove oriented in the direction of the axis of the cylinder tube, so as to be in contact with the outer surface of the cylinder tube, the attachment member is placed, with the sensor holding member fitted in a fitting groove in the lower surface of the attachment member, so as to straddle the sensor holding member, the attachment member and the sensor holding member are fixed to each other by tightening the attachment screw and fixing the attachment member between the clamping portions, and loosening the attachment screw allows the sensor holding member to be displaced relative to the attachment member in the direction of the axis of the cylinder tube.

According to a specific embodiment of the present invention, the position sensor has an indicator lamp that lights during operation, and a sensor fixing screw that fixes the position sensor in the sensor attachment groove, the attachment member has, at one end and the other end in a direction along the sensor attachment groove, a hollow portion and a see-through window each having such a depth that they extend from the upper surface of the attachment member to the fitting groove, the hollow portion is used for rotationally operating the sensor fixing screw with a tool, and the see-through window is used for viewing the indicator lamp.

In this case, it is preferable that the hollow portion and the see-through window be recesses formed so as to extend from one end and the other end of the attachment member toward the center of the attachment member and so as to face each other.

According to another specific embodiment of the present invention, on each of the left and right side surfaces of the attachment member, two ribs extending in the height direction of the attachment member are formed parallel to each other, and by placing the clamping portion of the attachment band between the two ribs, relative rotation between the clamping portion and the sensor holder about the attachment screw is prevented.

In the present invention, it is preferable that when the sensor holder is fixed to the outer periphery of the cylinder tube with the attachment band, the upper wall of the fitting groove be in contact with the upper surface of the sensor holding member, and the lower ends of both side walls of the fitting groove be out of contact with the outer surface of the cylinder tube.

In the present invention, it is preferable that one end of the sensor attachment groove be open, an insertion hole be formed at the one end, and the other end be closed by a wall.

In the present invention, a plurality of engaging recesses may be formed along the sensor attachment groove in rows, engaging protrusions engaging with the engaging recesses may be formed in the attachment member, the engaging pro-

trusions may be engaged with the engaging recesses when the attachment screw is tightened, and the engaging protrusions may be disengaged from the engaging recesses when the attachment screw is loosened.

In this case, it is preferable that the engaging recesses are formed on both left and right sides of the sensor attachment groove, and the engaging protrusions be formed on each of the left and right groove walls of the fitting groove in the attachment member.

In the present invention, stoppers that engage with the ends of the attachment member and prevent the sensor holding member from disengaging from the attachment member may be formed at one end and the other end of the sensor holding member in a direction along the sensor attachment groove.

In the present invention, a sensor fixing screw that fixes the position sensor in the sensor attachment groove may have a flange-like engaging portion on its head, the engaging portion may be able to be selectively engaged with an edge outer surface of an opening of the sensor attachment groove and the upper wall surface of a through-hole of the attachment member by rotating the sensor fixing screw clockwise and counterclockwise, the position sensor may be engaged with and fixed to an edge inner surface of the opening of the sensor attachment groove when the engaging portion is engaged with the edge outer surface, and the position sensor may be pressed against and fixed to the groove bottom of the sensor attachment groove when the engaging portion is engaged with the upper wall surface of the through-hole.

Advantageous Effects of Invention

According to the present invention, by loosening the attachment screw, the sensor holding member can be displaced with respect to the attachment member, with the attachment member held between the pair of clamping portions of the attachment band, to perform the position adjustment of the position sensor. In addition, the position sensor can be position-adjusted separately with respect to the sensor holding member. Therefore, the degree of freedom in position adjustment is high.

In addition, since it is not necessary to connect the attachment band and the sensor holder with an elongate hole or the like, the problem in that the position sensor is easily displaced along the elongate hole by vibration can be avoided.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a perspective view of an assembled state showing a first embodiment of a position detecting device according to the present invention.

FIG. **2** is an exploded perspective view showing the position detecting device of FIG. **1**.

FIG. **3** is a partial enlarged view of FIG. **2**.

FIG. **4** is a partial enlarged sectional view of FIG. **1**.

FIG. **5** is a sectional view taken along line V-V of FIG. **4**.

FIG. **6** is a perspective view of an assembled state showing a second embodiment of a position detecting device according to the present invention.

FIG. **7** is an exploded perspective view showing the sensor holder of FIG. **6**.

FIG. **8** is a cross-sectional view of FIG. **6**.

FIG. **9** is a sectional view taken along line IX-IX of FIG. **8**.

FIG. **10** is a perspective view of an assembled state showing a third embodiment of a position detecting device according to the present invention.

FIG. **11** is an exploded perspective view showing the sensor holder of FIG. **10**.

FIG. **12** is a sectional view showing a fixation embodiment of the position sensor with a sensor fixing screw.

FIG. **13** is a sectional view showing another fixation embodiment of the position sensor with a sensor fixing screw.

DESCRIPTION OF EMBODIMENTS

FIG. **1** to FIG. **5** show a first embodiment of a position detecting device according to the present invention. Reference sign **1** in the figures denotes a fluid pressure cylinder, and reference sign **2** denotes a position detecting device attached to the outer surface of the fluid pressure cylinder **1**.

The fluid pressure cylinder **1** has a cylinder tube **10** having a cylinder hole therein and having a cylindrical shape, and a rod cover **11** and a head cover **12** attached to both ends of the cylinder tube **10**. A piston **13** is contained within the cylinder tube **10** slidably in the direction of the central axis L of the cylinder tube **10** (hereinafter referred to as "tube axis"). A piston rod **14** whose proximal end is connected to the piston **13** slidably passes through the rod cover **11** and extends toward a position in front of the cylinder tube **10**.

Ports **15***a* and **15***b* are formed in the rod cover **11** and the head cover **12**. By alternately supplying and discharging pressure fluid (for example, compressed air) to and from pressure chambers on both sides of the piston **13** through the ports **15***a* and **15***b*, the piston **13** and the piston rod **14** is moved back and forth.

A ring-shaped permanent magnet **16** is attached to the outer periphery of the piston **13**. By detecting the magnetism of the permanent magnet **16** with the position detecting device **2**, the operating position of the piston **13** is detected. In this case, when the position detecting device **2** is attached to a part of the cylinder tube **10** near the rod cover **11** as shown, the position of the forward stroke end of the piston **13** can be detected. When the position detecting device **2** is attached to a part of the cylinder tube **10** near the head cover **12**, the position of the backward stroke end of the piston **13** can be detected. When two position detecting devices **2** are attached to parts of the cylinder tube **10** near both ends thereof, the positions of the forward stroke end and the backward stroke end of the piston **13** can be detected.

The position detecting device **2** includes a position sensor **17** that detects the magnetism of the permanent magnet **16**, a sensor holder **18**A that holds the position sensor **17**, an attachment band **20** that attaches the sensor holder **18**A to the outer periphery of the cylinder tube **10**, and an attachment screw **21** that performs the fixation of the attachment band **20** to the cylinder tube **10** and the fixation of the sensor holder **18**A to the attachment band **20** at the same time.

The attachment band **20** is formed by arcuately curving a strip-shaped elastic metal plate, preferably a non-magnetic metal plate, and has a band main body **20***a* surrounding the outer periphery of the cylinder tube **10** and a pair of clamping portions **20***b* and **20***c* formed at both ends of the band main body **20***a* so as to face each other. If necessary, belt-like or point-like antislip protrusions made of rubber, synthetic resin, or the like can be attached to the inner surface of the band main body **20***a*.

The inner surfaces of the pair of clamping portions **20***b* and **20***c* are flat clamping surfaces. Screw tightening holes **23***a* and **23***b* are formed in the pair of clamping portions **20***b* and **20***c*, respectively. The first screw tightening hole **23***a* formed in one of the clamping portions **20***b* is a normal hole on the inner surface of which an internal thread is not formed, and the second screw tightening hole **23***b* formed in the other clamping portion **20***c* is a threaded hole on the inner surface of which an internal thread is cut. An external thread at the distal

end of the attachment screw **21** inserted through the first screw tightening hole **23***a* is engaged with the internal thread on the inner surface of the second screw tightening hole **23***b*.

Of the pair of clamping portions **20***b* and **20***c*, at least the clamping portion **20***c* in which the second screw tightening hole **23***b* is formed is formed so as to be thicker than the band main body **20***a* by integrally joining or superimposing a reinforcing member to or on the end of the attachment band **20**, and can also be formed by folding the end of the attachment band **20**.

The attachment band **20** can also be formed of a hard and elastic synthetic resin.

The sensor holder **18**A includes a sensor holding member **26** having a sensor attachment groove **28** in which the position sensor **17** fits, and an attachment member **27** clamped between the clamping portions **20***b* and **20***c* of the attachment band **20**. The attachment member **27** and the sensor holding member **26** are separately formed of a non-magnetic material such as synthetic resin.

The sensor holding member **26** is a rod-shaped member that is more laterally elongate than the attachment member **27**, includes the sensor attachment groove **28** extending in the longitudinal direction thereof, and an opening **29** extending along the upper part of the sensor attachment groove **28**, and is placed with the sensor attachment groove **28** oriented in the direction of the axis L of the cylinder tube **10** and with the bottom surface in contact with the outer surface of the cylinder tube **10**.

The sensor attachment groove **28** has a major-arc-shaped cross-section, and therefore the width of the opening **29** is narrower than the groove width of the inside. One end (rear end) in the longitudinal direction of the sensor attachment groove **28** is open as a sensor insertion opening **28***a*, and the other end (front end) is closed by a wall **30**. The position sensor **17** is inserted through the sensor insertion opening **28***a* into the sensor attachment groove **28**, and is fixed in the sensor attachment groove **28** with a sensor fixing screw **31**.

The position sensor **17** has an elongate rod shape and includes a main body portion **17***a* having a major-arc-shaped cross-section, and a platform-like portion **17***b* formed on the top of the main body portion **17***a* and having a rectangular cross-section. The diameter (width) of the main body portion **17***a* is less than the width of the inside of the sensor attachment groove **28** but greater than the width of the opening **29**, and therefore the position sensor **17** can be engaged with the opening **29** from the inside of the groove.

The platform-like portion **17***b* fits in the opening **29** of the sensor attachment groove **28** and prevents rotation.

At the front end of the position sensor **17**, a threaded hole **17***c* is formed so as to extend through the position sensor **17** in a vertical direction. The sensor fixing screw **31** is screwed into the threaded hole **17***c*. In the middle of the position sensor **17**, an indicator lamp **17***d* that lights upon position detection is provided.

The sensor fixing screw **31** has a constant diameter. An operating groove **31***a* for rotationally operating the sensor fixing screw **31** with a tool such as a driver is formed in the upper surface of the sensor fixing screw **31**.

By screwing in the sensor fixing screw **31** and bringing the distal end thereof into contact with the groove bottom **28***b* of the sensor attachment groove **28**, the position sensor **17** is lifted, engaged with the edge of the opening **29** of the sensor attachment groove **28** from the inside, and thereby fixed in the sensor attachment groove **28**.

In the figures, reference sign **17***e* denotes a lead for taking out a position detection signal from the sensor.

At the lower ends of the left and right side surfaces of the sensor holding member **26**, protruding edges **34** protruding in the width direction of the sensor holding member **26** are formed throughout the length of the sensor holding member **26**. The upper ends of the left and right side surfaces, that is, the left and right shoulders of the sensor holding member **26** are chamfered to cut off the corners or formed into curved surfaces such as circular arcs. A plurality of engaging recesses **35** are formed in the left and right shoulders along the sensor attachment groove **28** at predetermined pitches in rows.

On the other hand, the attachment member **27** is a blockish member having a length about half the length of the sensor holding member **26**. In the lower surface of the attachment member **27**, an inverted U-shaped fitting groove **36** extending through the attachment member **27** from a first end **27***a* to a second end **27***b* in the direction of the cylinder axis L is formed. By fitting the sensor holding member **26** into the fitting groove **36**, the attachment member **27** is placed on top of the sensor holding member **26** so as to straddle the sensor holding member **26**.

The first end **27***a* of the attachment member **27** is the end on the side where the rear end of the sensor attachment groove **28**, that is, the wall **30** is located. The second end **27***b* is the end on the side where the front end of the sensor attachment groove **28**, that is, the sensor insertion opening **28***a* is located.

The fitting groove **36** has such a groove shape that a part of the sensor holding member **26** above the protruding edges **34** can fit in it. When the attachment member **27** is placed on top of the sensor holding member **26**, an upper wall **36***a* that is the groove bottom of the fitting groove **36** is in contact with the upper surface of the sensor holding member **26**.

Inside the fitting groove **36**, on left and right groove walls corresponding to the engaging recesses **35** of the sensor holding member **26**, a plurality of engaging protrusions **39** are formed at the same pitches as those of the engaging recesses **35** along the fitting groove **36** in rows. When the attachment member **27** is placed on top of the sensor holding member **26** and fixed with the attachment band **20** and the attachment screw **21**, the engaging protrusions **39** fit in and engage with the engaging recesses **35**.

Loosening the attachment screw **21** disengages the engaging protrusions **39** from the engaging recesses **35**, and allows the sensor holding member **26** to be displaced relative to the attachment member **27**.

The engaging protrusions **39** do not necessarily have to be formed on the left and right groove walls of the fitting groove **36** throughout the length of the fitting groove **36**. It is only necessary to form at least a pair of engaging protrusions **39** in the middle, at one end, or the other end of the fitting groove **36** such that they face each other.

The left and right side surfaces **27***c* of the attachment member **27** are contact surfaces with which the clamping portions **20***b* and **20***c* of the attachment band **20** are in contact, and are formed into flat surfaces parallel to each other. In the side surfaces **27***c*, a screw insertion hole **40** continuous with the screw tightening holes **23***a* and **23***b* of the clamping portions **20***b* and **20***c* is formed so as to extend through the attachment member **27** in the width direction.

The attachment screw **21** is inserted through the first screw tightening hole **23***a* of one of the clamping portions **20***b* into the screw insertion hole **40** and is then screwed into the second screw tightening hole **23***b* of the other clamping portion **20***c*. By tightening the attachment screw **21** and thereby moving the two clamping portions **20***b* and **20***c* toward each other, the attachment member **27** is clamped and fixed between the two clamping portions **20***b* and **20***c*, and the

sensor holding member **26** is pressed against and fixed to the outer surface of the cylinder tube **10** by the attachment member **27**. The engaging protrusions **39** of the attachment member **27** engage with the engaging recesses **35** of the sensor holding member **26**, and the sensor holding member **26** is prevented from being displaced.

At this time, the lower end of the attachment member **27**, that is, the lower ends of both side walls of the fitting groove **36** are not in contact with the outer surface of the cylinder tube **10**.

On the upper half of each of the left and right side surfaces **27***c* of the attachment member **27**, two ribs **41** extending in the height direction of the attachment member **27** are formed parallel to each other. By placing the clamping portion **20***b* of the attachment band **20** between the two ribs **41**, relative rotation between the clamping portion **20***b* and the sensor holder **18**A about the attachment screw **21** is prevented when the attachment screw **21** is tightened. The ribs **41** may be formed throughout the height of the attachment member **27**.

In the attachment member **27**, a hollow portion **42** and a see-through window **43** each having a U shape in plan view are formed so as to extend from the first end **27***a* and the second end **27***b* of the attachment member **27** along the sensor attachment groove **28**. The hollow portion **42** and the see-through window **43** each have such a depth that they extend from the upper surface of the attachment member **27** to the fitting groove **36**, and have the same width as the width of the opening **29** of the sensor attachment groove **28**. The hollow portion **42** is used for rotationally operating the sensor fixing screw **31** with a tool such as a driver. The see-through window **43** is used for viewing the indicator lamp **17***d* on the upper surface of the position sensor **17**.

The position detecting device **2** is configured as above. When the position adjustment of the position sensor **17** is performed, the engaging protrusions **39** are disengaged from the engaging recesses **35** by loosening the attachment screw **21** and thereby loosening the connection between the attachment member **27** and the sensor holding member **26**. In this state, the sensor holding member **26** is moved a necessary distance relative to the attachment member **27** in the direction of the cylinder axis L. After that, by tightening the attachment screw **21** again, the attachment portion is clamped and fixed between the clamping portions **20***b* and **20***c*, and the sensor holding member **26** is pressed against the outer surface of the cylinder tube **10** by the attachment member **27**. At the same time, the engaging protrusions **39** engage with the engaging recesses **35**, and the sensor holding member **26** is thereby fixed in a state where it is positioned in the position after the position adjustment.

Instead of displacing the sensor holding member **26**, the position sensor **17** can be displaced separately relative to the sensor holding member **26** by loosening the sensor fixing screw **31**. In this case, the attachment screw **21** need not be loosened.

Alternatively, the position adjustment can also be performed by displacing both the sensor holding member **26** and the position sensor **17**.

Therefore, the degree of freedom in position adjustment is high, and even when the attachment position of the attachment band **20** is restricted, the position adjustment of the position sensor **17** can be reliably performed.

In addition, since it is not necessary to connect the attachment band **20** and the sensor holder **18**A with an elongate hole, the problem in that the position sensor **17** is easily displaced along the elongate hole by vibration can be avoided.

FIG. **6** to FIG. **9** show a second embodiment of a sensor holder in the position detecting device of the present invention. The sensor holder **18**B of the second embodiment differs from the sensor holder **18**A of the first embodiment in that unlike the first embodiment, engaging recesses **35** and engaging protrusions **39** are not formed in the sensor holding member **26** and the attachment member **27**, and instead, stoppers **50***a* and **50***b* that come into contact and engage with the first end **27***a* and the second end **27***b* of the attachment member **27** and prevent the sensor holding member **26** from disengaging from the attachment member **27** are formed at one end and the other end of the sensor holding member **26** in a direction along the sensor attachment groove **28**.

That is, at the front end and rear end of the sensor holding member **26**, the stoppers **50***a* and **50***b* having the same width as the width of the sensor holding member **26** and protruding upward are formed. When the sensor holding member **26** is displaced maximally, the stoppers **50***a* and **50***b* engage with the first end **27***a* and the second end **27***b* of the attachment member **27**, and the sensor holding member **26** cannot be displaced further.

The configuration other than the above and the manner of attachment to the fluid pressure cylinder **1** of the second embodiment are substantially the same as those of the first embodiment. So, the same reference signs will be used to designate the same components as those in the first embodiment, and the description will be omitted.

As a modification of the sensor holder **18**B of the second embodiment, the stoppers **50***a* and **50***b* may be removed. This modification is specifically such that the engaging recesses **35** of the sensor holding member **26** and the engaging protrusions **39** of the attachment member **27** are removed from the sensor holder **18**A of the first embodiment.

FIG. **10** to FIG. **13** show a third embodiment of a sensor holder in the position detecting device of the present invention. This sensor holder **18**C differs from the sensor holder **18**A of the first embodiment mainly in that it employs a sensor fixing screw **31**A having a flange-like engaging portion **31***b* on its head.

The sensor fixing screw **31**A is screwed into the threaded hole **17***c* of the position sensor **17** such that its head protrudes through the opening **29** of the sensor attachment groove **28** of the sensor holding member **26** to the outside of the sensor attachment groove **28**. On the head, the engaging portion **31***b* that can engage with the flat edge outer surface **29***a* of the opening **29** of the sensor attachment groove **28** from the outside of the sensor attachment groove **28** is formed. Therefore, the diameter of the engaging portion **31***b* is greater than the width of the opening **29**.

In the attachment member **27**, above the fitting groove **36**, a through-hole **52** wider than the fitting groove **36** is formed along the fitting groove **36** so as to extend through the attachment member **27**. The hole width in the left-right direction of the through-hole **52** is greater than the width of the opening **29** of the sensor attachment groove **28** and the diameter of the engaging portion **31***b* of the sensor fixing screw **31**A. The vertical width (top-bottom width) of the through-hole **52** is greater than the thickness of the engaging portion **31***b* of the sensor fixing screw **31**A. The width of the hollow portion **42** is less than the diameter of the engaging portion **31***b* of the sensor fixing screw **31**A. Therefore, the engaging portion **31***b* can fit in the through-hole **52**, and the engaging portion **31***b* can come into contact with the upper wall surface **52***a* of the through-hole **52** in the position of the hollow portion **42**.

The engaging portion **31***b* preferably has a circular shape in plan view. Of the upper and lower surfaces of the engaging portion **31***b*, the lower surface part that comes into contact with the edge outer surface **29***a* and the upper surface part that comes into contact with the upper wall surface **52***a* of the

through-hole **52** are preferably formed into flat surfaces. In the upper surface of the engaging portion **31***b*, an operating groove **31***a* with which the tip of a tool such as a driver is engaged to rotationally operate is formed.

By rotating the sensor fixing screw **31**A clockwise or counterclockwise, the engaging portion **31***b* is selectively brought into contact with the edge outer surface **29***a* of the opening **29** of the sensor attachment groove **28** and the upper wall surface **52***a* of the through-hole **52**, and the position sensor **17** can thereby be fixed in the sensor attachment groove **28**.

That is, as shown in FIG. **12**, when the sensor fixing screw **31**A is rotated clockwise, the engaging portion **31***b* engages with the edge outer surface **29***a* of the opening **29** from the outside of the sensor attachment groove **28**, and therefore the position sensor **17** is pulled up by the sensor fixing screw **31**A, comes into contact and engages with the edge inner surface of the opening **29** of the sensor attachment groove **28** from the inside, and is fixed in the sensor attachment groove **28**. At this time, the engaging portion **31***b* engages with the flat edge outer surfaces **29***a* on both sides of the opening **29** so as to straddle them, and maintains a horizontal position, and therefore the position sensor **17** is also fixed horizontally. This method of fixation can be used both when the sensor fixing screw **31**A fits in the through-hole **52** in the position of the hollow portion **42** and when the sensor fixing screw **31**A is completely out of the through-hole **52**.

When the sensor fixing screw **31**A fits in the through-hole **52** in the position of the hollow portion **42**, as shown in FIG. **13**, rotating the sensor fixing screw **31**A counterclockwise through the hollow portion **42** with a tool lifts the sensor fixing screw **31**A and brings the engaging portion **31***b* into contact with the horizontal upper wall surface **52***a* of the through-hole **52**. By further rotating the sensor fixing screw **31**A in this state, the position sensor **17** is pressed against and fixed to the groove bottom **28***b* of the sensor attachment groove **28**. Also in this case, the engaging portion **31***b* comes into contact with the horizontal upper wall surface **52***a* and maintains a horizontal position, and therefore the position sensor **17** is also fixed horizontally.

As described above, by rotating the sensor fixing screw **31**A clockwise or counterclockwise and thereby selectively bringing the engaging portion **31***b* into contact with the edge outer surface **29***a* of the opening **29** of the sensor attachment groove **28** and the upper wall surface **52***a* of the through-hole **52**, the position sensor **17** can be fixed in a state where the position sensor **17** is out of contact with the groove bottom **28***b* of the sensor attachment groove **28** or a state where the position sensor **17** is pressed against the groove bottom **28***b*. The method of fixation of the position sensor **17** can be selected according to the installation condition of the position detecting device **2**.

The tip of the sensor fixing screw **31**A does not come into contact with the groove bottom **28***b* of the sensor attachment groove **28** both when the sensor fixing screw **31**A is rotated clockwise to fix the position sensor **17** and when the sensor fixing screw **31**A is rotated counterclockwise to fix the position sensor **17**, and therefore the groove bottom **28***b* of the sensor attachment groove **28** is not damaged by the sensor fixing screw **31**A. Therefore, the thickness of the groove bottom **28***b* can be reduced to improve the sensitivity of the position sensor **17**.

The configuration other than the above and the manner of attachment to the fluid pressure cylinder of the third embodiment are substantially the same as those of the first embodiment. So, the same reference signs will be used to designate the same components as those in the first embodiment, and the description will be omitted.

The configuration concerning the sensor fixing screw **31**A in the third embodiment can also be applied to the sensor holder **18**B of the second embodiment, in which the sensor holding member **26** and the attachment member **27** do not have engaging recesses **35** and engaging protrusions **39**, and the sensor holder **18**B of the second embodiment from which the stoppers **50***a* and **50***b* are removed.

In the embodiments described above, when the sensor holders **18**A, **18**B, and **18**C are formed of a synthetic resin, they can be formed of an opaque synthetic resin or a transparent synthetic resin. When they are formed of an opaque synthetic resin, it is desirable to form a see-through window **43** for viewing the indicator lamp **17***d* of the position sensor **17** as in each embodiment. When they are formed of a transparent synthetic resin, such a see-through window **43** does not necessarily have to be provided.

REFERENCE SIGNS LIST

1 fluid pressure cylinder
2 position detecting device
10 cylinder tube
13 piston
17 position sensor
17*d* indicator lamp
18A, **18**B, **18**C sensor holder
20 attachment band
20*a* band main body
20*b*, **20***c* clamping portion
21 attachment screw
26 sensor holding member
27 attachment member
27*a* first end
27*b* second end
28 sensor attachment groove
28*a* sensor insertion opening
28*b* groove bottom
29 opening
29*a* edge outer surface
31, **31**A sensor fixing screw
31*b* engaging portion
35 engaging recess
36 fitting groove
36*b* upper wall
39 engaging protrusion
41 rib
42 hollow portion
43 see-through window
50*a*, **50***b* stopper
52 through-hole
L axis

The invention claimed is:

1. A position detecting device for a fluid pressure cylinder, comprising: a position sensor that detects the position of a piston of a fluid pressure cylinder; a sensor holder that position-adjustably holds the position sensor; and an attachment band that attaches the sensor holder to the outer periphery of the fluid pressure cylinder,

wherein the attachment band has a band main body surrounding the outer periphery of the fluid pressure cylinder and a pair of clamping portions formed at respective opposite ends of the band main body so as to face each other,

wherein the sensor holder includes a sensor holding member having a sensor attachment groove in which the position sensor fits and an attachment member clamped between the pair of clamping portions of the attachment

band, and the sensor holding member and the attachment member are formed separately, and

wherein the sensor attachment groove is oriented in the direction of the axis of the fluid pressure cylinder, with the sensor holding member in contact with the outer surface of the fluid pressure cylinder, wherein the sensor holding member is fitted in a fitting groove in the lower surface of the attachment member, so as to be straddled by the attachment member, the attachment member and the sensor holding member are fixed to each other by tightening an attachment screw and fixing the attachment member between the clamping portions, and loosening the attachment screw allows the sensor holding member to be displaced relative to the attachment member in the direction of the axis of the fluid pressure cylinder.

2. The position detecting device according to claim **1**, wherein the position sensor has an indicator lamp that lights during operation and a sensor fixing screw that fixes the position sensor in the sensor attachment groove, the attachment member has, at one end and the other end in a direction along the sensor attachment groove, a hollow portion and a see-through window each having such a depth that they extend from the upper surface of the attachment member to the fitting groove, the hollow portion is used for rotationally operating the sensor fixing screw with a tool, and the see-through window is used for viewing the indicator lamp.

3. The position detecting device according to claim **2**, wherein the hollow portion and the see-through window are recesses formed so as to extend from one end and the other end of the attachment member toward the center of the attachment member.

4. The position detecting device according to claim **2**, wherein on each of the left and right side surfaces of the attachment member, two ribs extending in the height direction of the attachment member are formed parallel to each other, and by placing the clamping portion of the attachment band between the two ribs, relative rotation between the clamping portion and the sensor holder is prevented.

5. The position detecting device according to claim **2**, wherein when the sensor holder is fixed to the outer periphery of the fluid pressure cylinder with the attachment band, a upper wall of the fitting groove is in contact with a upper surface of the sensor holding member, and lower ends of both side walls of the fitting groove are out of contact with the outer surface of the fluid pressure cylinder.

6. The position detecting device according to claim **2**, wherein a plurality of engaging recesses are formed along the sensor attachment groove in rows, and engaging protrusions are formed in the attachment member, the engaging protrusions are engaged with the engaging recesses when the attachment screw is tightened, and the engaging protrusions are disengaged from the engaging recesses when the attachment screw is loosened.

7. The position detecting device according to claim **6**, wherein the engaging recesses are respectively formed on both left and right sides of the sensor attachment groove, and the engaging protrusions are formed on each of left and right groove walls of the fitting groove in the attachment member.

8. The position detecting device according to claim **2**, wherein stoppers that engage with the ends of the attachment member and prevent the sensor holding member from disengaging from the attachment member are formed at one end and the other end of the sensor holding member in a direction along the sensor attachment groove.

9. The position detecting device according to claim **2**, wherein a sensor fixing screw that fixes the position sensor in the sensor attachment groove has a flange-like engaging portion on its head, the engaging portion can be selectively engaged with an edge outer surface of an opening of the sensor attachment groove and the upper wall surface of a through-hole of the attachment member by rotating the sensor fixing screw clockwise and counterclockwise, the position sensor is engaged with and fixed to an edge inner surface of the opening of the sensor attachment groove when the engaging portion is engaged with the edge outer surface, and the position sensor is pressed against and fixed to the groove bottom of the sensor attachment groove when the engaging portion is engaged with the upper wall surface of the through-hole.

10. The position detecting device according to claim **1**, wherein on each of the left and right side surfaces of the attachment member, two ribs extending in the height direction of the attachment member are formed parallel to each other, and by placing the clamping portion of the attachment band between the two ribs, relative rotation between the clamping portion and the sensor holder is prevented.

11. The position detecting device according to claim **1**, wherein when the sensor holder is fixed to the outer periphery of the fluid pressure cylinder with the attachment band, an upper wall of the fitting groove is in contact with the upper surface of the sensor holding member, and lower ends of both side walls of the fitting groove are out of contact with the outer surface of the fluid pressure cylinder.

12. The position detecting device according to claim **1**, wherein one end of the sensor attachment groove includes an insertion hole in which the position sensor is inserted, and the other end is closed by a wall.

13. The position detecting device according to claim **1**, wherein a plurality of engaging recesses are formed along the sensor attachment groove in rows, and engaging protrusions are formed in the attachment member, the engaging protrusions are engaged with the engaging recesses when the attachment screw is tightened, and the engaging protrusions are disengaged from the engaging recesses when the attachment screw is loosened.

14. The position detecting device according to claim **13**, wherein the engaging recesses are respectively formed on both left and right sides of the sensor attachment groove, and the engaging protrusions are formed on each of left and right groove walls of the fitting groove in the attachment member.

15. The position detecting device according to claim **1**, wherein stoppers that engage with the ends of the attachment member and prevent the sensor holding member from disengaging from the attachment member are formed at one end and the other end of the sensor holding member in a direction along the sensor attachment groove.

16. The position detecting device according to claim **1**, wherein a sensor fixing screw that fixes the position sensor in the sensor attachment groove has a flange-like engaging portion on its head, the engaging portion can be selectively engaged with an edge outer surface of an opening of the sensor attachment groove and the upper wall surface of a through-hole of the attachment member by rotating the sensor fixing screw clockwise and counterclockwise, the position sensor is engaged with and fixed to an edge inner surface of the opening of the sensor attachment groove when the engaging portion is engaged with the edge outer surface, and the position sensor is pressed against and fixed to the groove bottom of the sensor attachment groove when the engaging portion is engaged with the upper wall surface of the through-hole.

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